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BARRIERS TO THE ADOPTION OF CLOUD COMPUTING IN GHANA: THE CASE OF SELECTED PUBLIC TERTIARY INSTITUTIONS

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ABSTRACT

A number of researches have shown that the adoption of cloud computing is associated with various barriers in both developed and developing countries. However this evidence is unavailable in the context of higher educational institutions in Ghana. This paper therefore identifies barriers to the adoption of cloud computing in public tertiary institutions in Ghana. The study's participants were IT/ICT lecturers and professionals in selected public tertiary institutions in Ghana. Purposive sampling was used to select 331 participants. A structured questionnaire was used to collect data. Data analysis shows that loss of full control over internal data and systems linked to clouds, the absence of formal compliance regulatory body in Ghana, the fact that availability of service providers may not be sustainable, and the possibility that cost of cloud services will rise in future are among serious barriers to cloud computing adoption. Lack of trust for cloud services and systems, and lack of confidence in the ability and promise of cloud computing are weaker barriers identified. Among all barriers identified, those relating to cost and future implications are the strongest. It is recommended that an attempt to formally adopt cloud computing in the selected universities requires a consideration of these challenges. Variables and constructs with higher strength are more important in terms of this consideration.

KEYWORDS: Cloud Computing, Adoption, Tertiary Institutions, Barriers, Teaching and Learning

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Original Article

INTRODUCTION

Cloud computing has over the years evolved as a utility in various industries such as banking, manufacturing, insurance, education, healthcare, to mention but a few. Though it is still an evolving technology, especially in developing countries (Tweneboah-Koduah, Endicott-Popovsky, and Tsetse, 2014), it is widely accepted as one of the most economical and efficient resources deployable in technology-user institutions. Moreover the debate that cloud computing is a tool for promoting business agility and serves as a paradigmatic remedy to the high cost of using information communication technologies has grown into a consensus among researchers (Okai, Uddin, Arshad, Alsaqour and Shah, 2014).

Cloud computing provides flexible on-demand and dynamically scalable computing infrastructure for many applications using any of its four models of deployment (Okai *et al.*, 2014). By depending primarily on the internet, the cloud technology can serve all kinds of users, namely individuals, businesses, industry, and perhaps other groups, at any location. One special characteristic of cloud computing is that it provides on-demand computing resources/networks on a pay-as-you-go basis through a cloud service provider (Ogbu and Lawal, 2013). This means that users can fully control their utility of the technology and therefore cut back on cost if the need be. Similarly, businesses and institutions can easily adapt their employees to the user-environment of the technology,

thereby boosting efficiency of both employees and the technology. Cloud computing also demands a productive redesign of the way businesses and institutions approach and accomplish their tasks routinely (Okai *et al.*, 2014). It therefore aligns and streamlines cross-office or cross-branch activities, a quality that forms the basis of its cost-effectiveness.

To academic institutions, cloud computing provides a wide array of benefits. For instance, Okai et al. (2014) observed that the cloud technology offers ample scalability and flexibility, and makes it possible for all users to access file storage, databases, and other applications anywhere and at any time. On the basis of this cited example, world-class universities have deployed this technology in very productive ways. For example, the University of Washington uses the cloud to implement collaborative learning for students at different locations (Okai et al., 2014; Ariwa and Ibe-Ariwa, 2014). In addition, the Pennsylvania State University in the United States uses cloud computing to share resources among its numerous campuses and colleges. Harvard University and Oxford University have also been identified as leaders in the harnessing of cloud computing systems in academia (Okai et al., 2014), whereas robust e-learning among such universities as Liverpool University and University of South Africa is facilitated using cloud computing (Ogbu and Lawal, 2013).

In the cloud computing literature, the efficient and productive use of cloud computing systems in academia is largely associated with developed countries. The fact that the universities cited above, except the University of South Africa, are in developed countries and economies attest to this situation. Moreover, researchers (e.g. Yeboah-Boateng and Essandoh, 2014; Seke, 2015) have observed and vehemently stated that cloud computing adoption in developing countries, particularly developing African countries, is either at the infantile stage or pre-adoption stage. In higher institutions of learning in African, very few universities have formally adopted cloud computing as a resource (Seke, 2015). In Ghana, to be specific, the adoption of cloud computing in tertiary institutions is either informal or is at the pre-adoption stage (Yeboah-Boateng and Cudjoe-Seshie, 2013). Invariably tertiary institutions in Ghana are either yet to formally employ cloud computing as an emerging technology, or the application of the technology is driven by the initiative of individual faculty members, students, and administrators. Thus the decision of individual faculty members, students, and administrators in Ghana to use cloud computing resources, which are often tapped into via service providers such as Google and Amazon, are not influenced by their universities. These individuals decide when and how to use cloud computing services, and how to finance such services used by them. Their utilisation of cloud technology services is not based on a formal arrangement or policy in their universities. It is also observed by some researchers (e.g. Gital and Zambuk, 2011; Iyanda, 2014) that even some of the few individuals who employ cloud technology systems and services in tertiary institutions in Africa are not aware of what they are using. This situation is attributable to a lack of knowledge on what constitutes cloud computing among students, lecturers and university administrators in Africa, for that matter Ghana.

Drawing from the argument of some writers (e.g. Yeboah-Boateng and Cudjoe-Seshie, 2013; Yeboah-Boateng and Essandoh, 2014), it could be said that the inability of tertiary institutions in Ghana to formally infuse cloud computing into teaching and learning is partly as a result of barriers or challenges. Considering the fact that world-class universities such as Harvard University and Oxford University are leveraging cloud computing to make giant strides in the world of academia, tertiary institutions in Ghana are irrefutably missing out in fully savoring cloud computing systems. In this study, barriers to the adoption of cloud computing in public tertiary institutions in Ghana are identified. The importance of the study is based on the fact that no identifiable study has been conducted in a Ghanaian context to contribute to knowledge on barriers to the adoption of cloud computing in tertiary institutions. Moreover, no study has drawn from appropriate theoretical frameworks such as the framework of Technology, Organization and Environment to explain barriers to the adoption of cloud computing in tertiary institutions in Ghana.

RESEARCH OBJECTIVE

This study identifies barriers to the adoption of cloud computing in public tertiary institutions in Ghana. This study identifies these barriers by throwing light on their strength and relating them to the three contexts of Technology, Organization and Environment framework which are: characteristics of cloud computing, characteristics of tertiary institutions and nature of the Ghanaian environment.

SIGNIFICANCE OF THE STUDY

There is a strong academic proposal, at least among some researchers (e.g. Yeboah-Boateng and Cudjoe-Seshie, 2013; Yeboah-Boateng and Essandoh, 2014; Tweneboah-Koduah *et al.*, 2014) for the adoption of cloud computing in Ghanaian businesses and institutions. Yet the adoption of cloud computing in any jurisdiction is constrained by some barriers such. By implication, knowledge of these barriers is relevant to effectively considering them in adopting cloud computing, or finding their remedy prior to the adoption of cloud computing in tertiary institutions in Ghana. This study contributes to establishing accurate knowledge of these barriers. This paper also generally contributes to the literature and academic debate on the concept of cloud computing from a Ghanaian point of view.

LITERATURE REVIEW

There are a number of definitions of cloud computing. Yet there is no reason touching on all definitions since they convey the same understanding. The most recent definition comes from Seke (2015, p. 2): it is a consumer/delivery model where information technology capabilities are offered as services billed based on usage. As acknowledged earlier, this definition is not different from others. For instance, Okai *et al.* (2014, p. 1) defined it as an internet-dependent technology that allows access to networks, databases and other resources based on a pay-as-you-go service scheme. The term pay-as-you-go means that users pay for cloud services along the continuum of their application history, thereby making it possible for them to control spending and budget.

Cloud computing has several properties, some of which have been mentioned. But one of the most admirable is its efficiency and cost-effectiveness (Iyanda, 2014). It is also always on-demand, and it is adjudged one of the most dynamically scalable among computing paradigms (Okai *et al.*, 2014; Seke, 2015). It operates on four development models, namely private, public, community, or hybrid, and three service delivery models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

IaaS is the foundation of cloud services which provides clients with access to server hardware, storage, bandwidth and other primary resources of computing, including those relevant to other computing paradigms (Mircea and Andreescu, 2011; Mohammed *et al.*, 2015). An example is Amazon's EC2, which allows individuals and businesses to rent machines preconfigured with selected operating systems. Machines rented can be used remotely by businesses to run their own programs and operations.

PaaS is technically an outcome of IaaS, and provides clients with access to the basic operating software and optional services to develop and use software applications such as payment services or systems (Mohammed *et al.*, 2015). To illustrate, *Google App Engine* allows clients to run their web applications such as Internet Explorer over the internet on Google's infrastructure.

SaaS is also built on the functionality of IaaS and PaaS. Its basic role is to provide clients with integrated access to software applications (Mohammed *et al.*, 2015). For instance, Oracle's SaaS platform allows independent software vendors to develop, deploy and manage SaaS and cloud-based applications and systems using a licensing model. The three service models of IaaS, PaaS and SaaS have several specific examples. Examples of each service model are as follows (Seke, 2015):

SaaS: E-mail, communication, virtual desktop

PaaS: Database, web server, development tools

IaaS: Virtual machines, servers, storage, network

As cited earlier, cloud computing is relevant to the management of businesses and organizations. It is particularly useful to tertiary institutions of higher learning. The earlier cited examples on the deployment of cloud computing by some world-class universities attest to this assertion. However, as posited by various writers (e.g. Tweneboah-Koduah *et al.*, 2014; Avram, 2014; Awosam, 2014), the adoption of this technology is constrained by several factors or barriers. It is therefore logical to think that these barriers apply to adoption of cloud computing in tertiary institutions as well. In this study, barriers to the adoption of cloud computing in public tertiary institutions in Ghana are identified. Though cloud computing research has been conducted based on various theories, this study identifies the said barriers by drawing from the Technology, Organization and Environment (TOE) framework.

TOE was originally developed by Rogers in 1962, but was later modified by Tornatzky and Fleischer in 1990. The framework identifies three key constructs that influence the process by which an organization adopts and implements technological innovation. The first of these is the *technology context*, which refers to the relationship between characteristics of the technology to be adopted and the current state of technology in the organization, in this case the tertiary institution. The current state of technology can be expressed in terms of equipment owned by the organization, referred to as *material*, and technological methods being currently used, referred to as *immaterial* (Tweneboah-Koduah *et al.*, 2014). It is assumed that new technology adoption would conflict existing systems (i.e. material and immaterial), at least in terms of funding. This conflict is an embodiment of some barriers to adoption of the new technology (Mohammed *et al.*, 2015). For instance, one of the popular barriers to cloud computing adoption in the literature is "loss of control as a result of depending on service providers" and "high cost of initial adoption". These two barriers are underpinned by the first context of TOE.

The second context is *organizational context*, which consists of the organization's structure and presence of innovation-enabling processes (Tweneboah-Koduah *et al.*, 2014). Some barriers are also assumed to be underpinned by this context such as those based on weaknesses of a university. A specific example is "a lack of knowledge by faculty members and administrators on cloud computing", which gives rise to the need for them to be trained before its adoption. The third context is the *environmental context*, which combines elements such as market structure, the external support available for adopting new technologies and government regulations. The environment context also underpins challenges such as "unavailability of service providers" and "unavailability of support from government". Also the regulatory environment may not exist to ensure security and confidentiality with regard to tapping into clouds.

In this paper, we draw from TOE by identifying and categorizing barriers based on its three contexts: barriers relating to weaknesses of the technology in the context of academic institutional management; barriers relating to the

academic institutions; and barriers relating to the environment. In view of the fact that several researchers (e.g. Tweneboah-Koduah *et al.*, 2014; Avram, 2014; Mohammed *et al.*, 2015) have used TOE to identify factors, including barriers, affecting the adoption of cloud computing, we draw from it for the first time in Ghana to identify barriers to the adoption of the technology in public tertiary institutions. Moreover based on TOE, several barriers have been found to hinder the adoption of cloud computing in both developed and developing country contexts. Some of these challenges are with respect to trust, cost, security, loss of control, infrastructure and human resource gaps. In this paper, we adapt from this evidence and introduce potential challenges that are unique to public tertiary institutions in Ghana. Since public tertiary institutions in Ghana are highly dependent on government, we argue that some barriers relating to government would hinder the adoption of cloud computing in these institutions. Moreover, some barriers identified in the literature (e.g. trust, cost, security, loss of control, infrastructure, human resource misfits, etc.) are constructs that need a breakdown. In this paper, we attempt to improve understanding of these constructs by representing them with more specific manifest variables.

METHODS

Cloud computing is still a paradigm that falls out of public notice in many developing countries. Yeboah-Boateng and Essandoh (2013) and other researchers observed that this situation applies to Ghana. Hence there are specific and few people who have ample knowledge on cloud computing. Therefore to choose participants in this study, a purposive sampling approach was used. The use of this sampling method was determined by the criteria set for choosing respondents. These criteria are:

- Participant must be an IT professional in the IT department of a public university in Ghana, or must be an IT/ICT lecturer.
- Participant must have used at least one or postgraduate service model of cloud computing at the individual level, or must have acquired knowledge on this technology in an undergraduate course.

The general criterion for participating in this study was having ample theoretical or practical knowledge on cloud computing in some public tertiary institutions. We chose participants from public universities which we thought should formally adopt cloud computing and can be supported by government to do so. These institutions are University of Ghana (UG), University of Cape Coast (UCC) and Kwame Nkrumah University of Science and Technology (KNUST). With the assistance of the Human Resource Managers of these institutions, 331 potential participants (i.e. 205 IT/ICT professionals and 126 lecturers) were reached. Table 1 shows details of this population.

Table 1: Details on the Study Population

University	ITC/IT Professionals	Lecturers	Total
UG	98	61	159
UCC	44	28	72
KNUST	63	37	100
Total	**205**	**126**	**331**

We realized that collecting data on the total of 331 participants across the universities was supported by our financial capacity and time schedule. As a result, a census method was used in which all participants were surveyed.

A questionnaire survey method was employed; thus a structured and self-administered questionnaire was used to collect data. A self-administered questionnaire was used to make it possible for respondents to respond online and with little assistance from the researchers. The use of this questionnaire type was supported by the fact that a review of the

literature had informed researchers about all manifest variables to include in the questionnaire, thereby giving rise to the need to use very few open-ended questions.

In the questionnaire, respondents were asked to score from 1 to 5 the extent to which a statement (e.g. there will be difficulty associated with integrating cloud computing with existing systems) was perceived as a barrier to the adoption of cloud computing in their universities. In this case, 1 stands for a weakly perceived barrier, while 5 stands for a very highly perceived barrier. Data collected in this study was therefore continuous in nature.

Our priority was to take some steps to achieve validity and reliability. In the case of reliability, we ensured that statements were either directly based on some reputable previous studies or were adapted from standard scales. Moreover, the statements were presented in dimensions or conceptually related groups as suggested by some writers (e.g. Morse, 2002; Drost, 2011) so that reliability could be verified. As a result, unique variables captured in this study and the fact that some statements were adapted from the literature did not become a threat to reliability. Table 2 shows evidences of the dimensionality or reliability of the four constructs formed by the variables measured. In this table, each constructs is sufficiently dimensional in view of having a Cronbach's alpha of at least 0.50, which is largely greater than the minimum value of 0.07 that a dimensional or reliable construct could take (Drost, 2011).

Table 2: Tests of Dimensionality

Dimension	N	Cronbach's alpha	Items Removed
Internal university environment	243	0.677	None
Government and regulation	243	0.506	None
Service providers, Security and Infrastructure	243	0.529	None
Cost and future implications	243	0.598	None

To achieve content validity, the measurement instrument was given to three experts in the subject area to review. Reviewers' approval of the questionnaire established face validity. A pilot study was also conducted using 25 of the participants. Data collected in the pilot study was correlated to actual data to establish convergent validity. Thus a strong correlation ($r > .50$) existed between each dimension of the questionnaire of the piloted data and actual data.

Before data was collected, the Human Resource Managers assisted researchers to lay hands on participants' email addresses and telephone numbers, possibly after the managers had asked permission from the participants. Emails were then sent to potential participants to inform them of the study and to ask them to sign an informed consent form. Respondents who could not respond to emails were called about a week after sending emails. After participants had agreed to look at the informed consent form, it was emailed to them. Some immediately agreed to participate, while others were called after a while to verbally explain the informed consent form before they accepted to participate. The informed consent form used is shown in Appendix B.

After participants had signed the informed consent forms, questionnaires were administered mostly online, while a few were issued by hand delivery. Participants were given two weeks to respond. Within this period, follow up calls were made to remind respondents of the need to fill questionnaires. However some of them did not respond after the two weeks allocated; hence a grace period of a week was given. After the grace period had elapsed, 294 questionnaires were completed and returned by respondents, out of which 243 were analyzed. Thus 51 questionnaires were discarded owing to an excessive number of response and non-response errors made in them.

Questionnaires were coded and entered into SPSS version 21, after which entered data was checked for outliers using skewness and kurtosis statistics. In the main analysis, SPSS was used to compute the arithmetic mean of each statement or variable. The arithmetic mean was used to show the extent to which a variable was perceived as a barrier. The following classification was used in the analysis:

- Mean value between 1 and 1.99 represents **lowly** perceived challenge
- Mean value between 2 and 2.99 represents **medium** or **fairly considerable** challenge
- Mean value between 3 and 3.99 represents **high** challenge
- Mean value between 4 and 5 represents **very high** challenge

Based on the above four classifications, the strength of each challenge and dimension was identified and communicated.

RESULTS

In this section, results of data analysis are presented. These results are presented in Tables 4 to 8 in Appendix A. Table 3 shows a summary of findings.

Table 3: Strength of Barriers

Dimension	Barrier of Adoption	Mean	Strength
Internal university environment	Lack of trust for cloud services and systems	2.44	Medium
	Difficulty associated with integrating cloud computing with existing systems	3.56	High
	Loss of full control over internal data and systems linked to clouds	4.11	Very high
	Lack of confidence in ability and promise of the cloud	2.00	Medium
	Management of the university may not be committed	3.56	High
	The university does not have funds to finance formal adoption internally	3.56	High
	Lack of internal expertise and knowledge	3.33	High
Government and regulation	Statutory laws and regulations in developed countries may not apply to Ghana	3.44	High
	No formal compliance regulatory body exists	3.89	High
	There are no standards about which quality, trust and confidentiality is monitored	3.11	High
	Government may not support formal use of the system	3.56	High
	Demanding the government to support cloud computing adoption may weaken its responsibility to other needs of the university	4.00	Very high
Service providers, Security and Infrastructure	Poor internet access and connectivity	4.33	Very high
	Unavailability of service providers	3.33	High
	Availability of service providers may not be sustainable	4.56	Very high
	Incompetence by service providers would badly affect usage of the service	4.22	Very high
	Security of cloud services is not guaranteed	4.22	Very high
	Storage of data is not necessarily secure	4.33	Very high
	Lack of trust for cloud services and systems	2.11	Medium
	Delay in transfer and migration of data	3.87	High

Table 3: Contd.,

Cost and future implications	High cost of initial adoption	4.22	Very high
	The possibility that cost of cloud services will rise in future	4.56	Very high
	The economic and social consequences that could be suffered if the university decides to sign out of cloud services	4.00	Very high

Table 4 coupled with Table 3 shows barriers with respect to *Internal University Environment*. In this table, the bulk of the variables have **high** strength, while only one (i.e. Loss of full control over internal data and systems linked to clouds) has **very high** strength. Also "lack of confidence in ability and promise of the cloud" and "lack of trust for cloud services and systems" have **medium** strength. With respect to *Government and regulation*, all variables have **high** strength, while only "demanding the government to support cloud computing adoption may weaken its responsibility to other needs of the university" has a **very high** strength. Considering the dimension of *Service providers, Security and Infrastructure*, all variables represent **very high** challenges, except "Unavailability of service providers" (Mean = 3.33; High), "Delay in transfer and migration of data" (Mean = 3.87, High) and "Lack of trust for cloud services and systems" (Mean = 2.11, Medium). For the fourth dimension *Cost and future implications*, all variables represent **very high** barriers.

With respect to Table 8 in Appendix A, all dimensions are high, except *Cost and future implications*, which is estimated to be **very high** (Mean = 4.26). The second strongest dimension is *Service providers, Security and Infrastructure* (Mean = 3.87), which is literary because most of its variables have **very high** status. While every variable is, to some extent, a barrier to the adoption of cloud computing in the selected universities, those of *cost and future implications* are the strongest.

DISCUSSION OF FINDINGS

In this study, we adapted previous studies to provide knowledge on barriers to the adoption of cloud computing in Ghanaian public tertiary institutions. All variables or statements measured in the questionnaire (see Table 3) were perceived, at varying extents, as barriers to the adoption of cloud computing in public tertiary institutions in Ghana. Every barrier identified in this study is supported by either TOE or a collection of previous studies. From the perspective of TOE, each challenge belongs to one context: (a) a weakness characteristic of cloud computing (e.g. its dependence on internet); (b) institutional situation (e.g. faculty members, students and administrators not having knowledge on cloud computing); and (c) general environment (e.g. lack of service providers and regulatory standards in Ghana). Moreover, other studies conducted in a Ghanaian context but not on tertiary institutions (e.g. Yeboah-Boateng and Cudjoe-Seshie, 2013; Tweneboah-Koduah *et al.*, 2014) have supported most of these barriers from the perspective of TOE. The few barriers in this study not related to previous studies conducted in Ghana are those relating to government's involvement in financing cloud computing adoption and those relating to some special characteristics of universities.

Also in both developed and developing country contexts, this study's findings, except for the said unique variables captured, are in harmony with several studies (e.g. Avram, 2014; Awosam, 2014; Ghaffari *et al.*, 2014). This is to say that, apart from unique variables, barriers found in this study apply to both developed and developing countries. In this regard, Ghaffari *et al.* (2014) observed that most barriers to cloud computing adoption are the same across jurisdictions and industries, except in specific industries in which a few unique barriers may exist. This observation brings to light the need to contrast findings of this study with those of previous studies conducted in academia.

Findings in this study are generally consistent with most studies conducted in academia (e.g. Gital and Zambuk, 2011; Ariwa and Ibe-Ariwa, 2014; Adeoye, 2015). However while these previous studies identified barriers in the form of broad statements (e.g. cost, security, human resource and convenience barriers), this paper identified them with precise variables. For instance, two variables used to capture "security" in this study are "security of cloud services is not guaranteed" and "storage of data is not necessarily secure". On the basis of this uniqueness of our study, it is hoped that the ambiguity associated with variables of previous studies is remedied.

CONCLUSIONS AND RECOMMENDATION

All variables captured in Table 3, at varying extents, represent barriers to the adoption of cloud computing in the selected tertiary institutions in Ghana. Some variables such as "loss of full control over internal data and systems linked to clouds", "poor internet access and connectivity" and "high cost of initial adoption" are perceived to have very high strength, while other variables are either perceived to have medium strength or high strength. All dimensions of the barriers are perceived to have high strength, but *cost and future implications* are perceived to have a **very high** strength.

Based on the results, an attempt to formally adopt cloud computing in the selected universities requires a consideration of these challenges. Variables and constructs with higher strength are more important in terms of this consideration.

LIMITATION AND SUGGESTION FOR FUTURE RESEARCH

Despite the significance of this study, we would want to admit that the general sampling method and research design used is not appropriate for inferring findings to the selected tertiary institutions, let alone Ghana. This is another way to say that the study has no or little external validity. We are however sure that this study could be used to conduct studies that provide findings that could be generalised to Ghana. In these future studies, the use of probability sampling methods and inferential statistical tools would be needed. A more robust analysis can be done in future studies by using Factor Analysis or/and Principal Component Analysis to better classify the barriers reached in this study, or based on an adaptation of this study's findings.

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APPENDICES

Appendix A

Table 4: Barriers – Internal University Environment

	N	Minimum	Maximum	Mean	Std. Deviation
Lack of trust for cloud services and systems	243	1.00	4.00	2.44	1.17
Difficulty associated with integrating cloud computing with existing systems	243	2.00	5.00	3.56	0.96
Loss of full control over internal data and systems linked to clouds	243	2.00	5.00	4.11	1.10
Lack of confidence in ability and promise of the cloud	243	1.00	4.00	2.00	0.94
Management of the university may not be committed	243	1.00	5.00	3.56	1.17
The university does not have funds to finance formal adoption internally	243	2.00	5.00	3.56	1.07
Lack of internal expertise and knowledge	243	1.00	5.00	3.33	1.42

Table 5: Barriers – Government and Regulation

	N	Minimum	Maximum	Mean	Std. Deviation
Statutory laws and regulations in developed countries may not apply to Ghana	243	1.00	5.00	3.44	1.35
No formal compliance regulatory body exists	243	1.00	5.00	3.89	1.20

Table 5: Contd.,

There are no standards about which quality, trust and confidentiality is monitored	243	1.00	5.00	3.11	1.37
Government may not support formal use of the system	243	1.00	5.00	3.56	1.35
Demanding the government to support cloud computing adoption may weaken its responsibility to other needs of the university	243	2.00	5.00	4.00	0.94

Table 6: Barriers – Service Providers, Security and Infrastructure

	N	Minimum	Maximum	Mean	Std. Deviation
Poor internet access and connectivity	243	3.00	5.00	4.33	0.82
Unavailability of service providers	243	2.00	5.00	3.33	0.94
Availability of service providers may not be sustainable	243	3.00	5.00	4.56	0.69
Incompetence by service providers would badly affect usage of the service	243	3.00	5.00	4.22	0.63
Security of cloud services is not guaranteed	243	3.00	5.00	4.22	0.63
Storage of data is not necessarily secure	243	3.00	5.00	4.33	0.82
Lack of trust for cloud services and systems	243	1.00	4.00	2.11	1.00
Delay in transfer and migration of data	243	3.29	4.43	3.87	0.36

Table 7: Barriers – Cost and Future Implications

	N	Minimum	Maximum	Mean	Std. Deviation
High cost of initial adoption	243	2	5	4.22	1.03
The possibility that cost of cloud services will rise in future	243	3	5	4.56	0.69
The economic and social consequences that could be suffered if the university decides to sign out of cloud services	243	2	5	4.00	1.06

Table 8: Dimensions of Barriers

	N	Minimum	Maximum	Mean	Std. Deviation
Internal university environment	243	2.43	4.14	3.22	0.66
Government and regulation	243	2.60	4.80	3.60	0.73
Service providers, Security and Infrastructure	243	3.29	4.43	3.87	0.36
Cost and future implications	243	3.00	5.00	4.26	0.70

APPENDIX B

Informed Consent

Dear potential participant, we seek to conduct a study to identify challenges associated with the adoption of cloud computing in tertiary institutions in Ghana. We are undertaking this research to contribute to the debate on the need to adopt cloud computing in facilitating teaching and learning in our tertiary institutions.

With support from the HR department of this university, you are found to be a potential respondent in this study. Therefore we would appreciate it if you would participate in this study as a respondent. Apart from making time to respond to questionnaires, we are sure this study would not have any negative effect on you, especially owing to the fact that we will treat your participation and your responses with confidentiality. Moreover your responses shall be used for only

academic purposes, and the final published copy of the research will be forwarded to you. You can rest assured; your responses will not be made to disclose your identify.

You will benefit as a participant by having access to an electronic version and hard copy of the published research. Your university is also captured in this study as an institution which needs government support to adopt cloud computing.

Regardless of the benefits of this study and other assurances, you reserve the right to refuse to participate, or you can withdraw from the study at any time before the results are published. We however hope that you would participate to help us contribute to knowledge and academic debate on the topic.